METHOD FOR THE MANUFACTURE OF UNDERGROUND PIPES OR TUNNELS OR LARGE DIAMETER

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Inventor:

Applicant: ZUEBLIN AG

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(54) METHOD FOR THE MANUFACTURE OF UNDERGROUND PIPES OR TUNNELS OF LARGE DIAMETER

(71) We, ED. ZÜBLIN AKTIENGESELLSCHAFT, a Company organised under the Laws of the Federal Republic of Germany, of 22 Jägerstrasse, 7000 Stuttgart 1, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to method and a means for the construction of underground pipes or tunnels.

It is known to join together reinforced concrete pipes of large diameter to form a pipeline which serves as an underground transporting path, for example, for liquid (Journal "Betonwerk + Fertigteil-Technik" (Concrete Work and Finished Part Technology) 41 (1975), pages 424—429). These pipes may be laid in open ditches and joined together to form a pipeline. It is, however, also possible to make such a transporting path by the pressing through method, which involves forcing a tubular element along a pre-cut passage and into position therein. In doing so the pipeline is lengthened at intervals by the addition of further pipes and pressed suitably sectionwise into the ground. The leading pipe is, in this case, provided with a propulsion plate or cutting shoe.

If the reinforced concrete pipes to be joined together to form the pipeline are delivered to the site as finished parts, the diameter of the pipe cannot be selected as large as desired because, with the dimensioning of the pipes, the transport possibilities must be taken into consideration. Thus, the width of the pipes has to be considered because of the supporting capacity of the transport vehicle and of any bridges to be driven over; in addition, the outer diameter and the length of the individual pipes should not exceed dimensions which are determined by the width and the height of the transport. These transport problems are partly solved in that, in the vicinity of the site, so-called field factories are set up which are only in operation for the duration of the building time so that short transport paths are available which are suitable for the delivery of even larger pipes. However, all transport difficulties cannot be removed, especially since the local conditions frequently do not permit of an erection of such field factories in the direct vicinity of the building site.

Underground transport paths of large cross-section, in particular tunnels for rail or motor vehicles, are for the most part made in such manner that first of all a tunnel is dug, the wall of which is then lined or cladded in step with the advance of the tunnel, concrete finished parts also being used.

The invention accordingly is based on the problem of being able to construct in accordance with the foregoing method in which reinforced concrete pipes are to be joined to make a pipeline, very large cross-section transport paths using reinforced concrete finished parts without the diameters of the pipes being limited due to the supporting capacity of the transport vehicles and local traffic conditions.

According to the present invention there is proposed a method of constructing large cross-section underground pipes or tunnels by joining together reinforced concrete pipes in end-to-end disposition to form a pipeline, characterised in that the reinforced concrete pipes are assembled from prefabricated completed part-casing pieces which are connected together at their longitudinal joints at the building site before laying and the assembled pipes are then brought one after the other into their final underground positions.

The method according to the invention renders possible on the one hand the delivery of the reinforced concrete pipes to the site in part pieces and on the other hand the

manufacture of a pipeline from reinforced concrete pipes which can be laid in an open construction pit or in an open trench, preferably however in the pressing through method. The prefabricated part-casing pieces are suitably joined together in a construction pit to form a reinforced concrete pipe and the reinforced concrete pipes thus produced may then be brought from the construction pit direct into their "use" positions. With the use of the pressing through method the respective finished reinforced concrete pipe is connected in known manner with the already finished pipeline at a transverse joint and the pipeline is moved forward section-wise by pressing and is thereby pressed into a preformed tunnel in the ground.

The invention also provides a tunnel constructed in accordance with the method.

The invention will now be described further, by way of example only, with reference to the accompanying drawings illustrating several embodiments thereof, and in which:—

Fig. 1 is a diagrammatic illustration of an assembled cylindrical reinforced concrete pipe formed from two similar casing pieces;

Fig. 2 shows a cylindrical reinforced concrete pipe consisting of three similar casing pieces;

Fig. 3 shows a cylindrical reinforced concrete pipe which is composed of four equal casing pieces;

Fig. 4 is a diagrammatic illustration of a cylindrical reinforced concrete pipe assembled from two part-casing pieces of a different form from those shown in Fig. 1;

Fig. 5 shows a further embodiment of a cylindrical reinforced concrete pipe consisting of two part-casing pieces; and

Fig. 6 shows a reinforced concrete pipe formed from two part-casing pieces arranged in axially offset disposition.

Referring now to the drawings, and particularly to Fig. 1 thereof, a cylindrical reinforced concrete pipe 1 consists of two part-casing pieces 2 and 3 which are each of part-cylindrical form and subtend an angle of approximately 180° at the centre thereof. The two part-casing pieces 2, 3 are therefore semi-circular shells which form at their abutting places longitudinal joints 4 and 5. These abutment joints are sealed by, for example, conventional seals or a sealing medium, such as a durable elastic cement. The two semi-circular shells are tightened against each other by clamping members 6 and 7. The clamping members 6 and 7 are in the form of tension wires which extend crosswise to the longitudinal joints 4 and 5, respectively, along a chord of the periphery of the reinforced concrete pipe through the concrete of the tube casing. Recesses 8 and 9 are provided in the casing pieces 2, 3 in the vicinity of the longitudinal edges of such casing pieces, and thus adjacent the joints 4 and 5, and receive the anchors 10 of the clamping members. Recesses 8 are provided for the anchoring of the clamping members 6, and are approximately square when viewed in plan, whilst recess 9 is rectangular, the longitudinal edges thereof being parallel to the joint 4. Recess 9 receives the anchors 10 of four adjacent clamping members. The recesses are formed niche-shaped so that the anchoring means of the clamping members are countersunk in the pipe casing and therefore do not form an obstruction when the pipe is forced into the ground axially of its length. The shape of the individual recesses and their distribution lengthwise of the pipe are determined according to the specific requirements of the situation and should, in any case, be so selected as to be easily accessible for tightening and anchoring of the clamping members. Recesses 8 which are intended for the tension wires may be provided and distributed exclusively over the whole length of the pipe. It is, however, also possible to provide in the vicinity of each longitudinal edge of the part-casing pieces a recess common to all tension wires, which recess is formed in like manner to recess 9 and extends to positions adjacent the ends of the pipe.

The longitudinal joints 4 and 5 may be formed as articulated connections which may have a predetermined ridigity, so that the movement of the part-casing pieces towards one another is limited. For this purpose the abutting surfaces of adjacent part-casing pieces may be relatively offset so as to form a lap type joint. Elastic intermediate layers may also be arranged in the longitudinal joints. The forming of articulated connections at the abutting places has the advantage that the laid pipes can deform a little to accommodate external or, in the case of conduits for the passage of liquids, internal pressures. When articulated longitudinal connections are provided, the lateral-joints between the individual pipes of the pipeline are also formed as articulated joints in manner known *per se*. According to the intended use and the dimensions of the pipes, the part-casing pieces may be connected by rigid longitudinal joints.

The part-casing pieces are reinforced, and such reinforcement may take the form of basket-like or net-like structures wherein longitudinal wires and cross-wires are welded together.

Figs. 2 and 3 show a reinforced concrete pipe section composed of three and four similar part-casing pieces assembled together to form a pipe of circular cross-section. The cross-section of the part-casing pieces 11, 12 and 13 of the pipe 1*a* shown in Fig. 2 corresponds to a segment of a circle having a centre angle of 120°, whilst the four-part

casing pieces 14, 15, 16 and 17 of the pipe 1*b* shown in Fig. 3 are likewise segment-shaped in cross-section and have a centre angle of 90°. The construction and formation of the pipes 1*a* and 1*b* shown in Figs. 2 and 3, respectively correspond to that of pipe 1 as shown in Fig. 1.

The pipe 1*c* shown in Fig. 4 consists of two part-cylindrical half shells 2*a* and 3*a*. These two part-casing pieces have, at their longitudinal edges, flanges 18, 19 and 20, 21 which are formed integrally with the appropriate part-casing piece 2*a* and 3*a*, respectively. The flanges are directed radially inwardly of the respective part-casing piece so as not to impair the smoothness of the outer casing surface of the pipe and thus hinder the progressive engagement of the pipe with the ground under axially applied pressure. The two longitudinal joints 4*a* and 5*a* are formed at the abutting places of flanges 18, 20 and of the flanges 19, 21. For connecting the two part-casing pieces 2*a* and 3*a*, clamping members 6*a* and 7*a* respectively are provided crosswise through the pairs of flanges 18, 20 and 19, 21. For guiding and anchoring the clamping members, recesses 8*a* are provided in the flanges, such flanges being arranged similarly to the recesses 8 and 9 as shown in Fig. 1. The longitudinal joints 4*a* and 5*a*, as with the pipe shown in Fig. 1. The longitudinal joints 4*a* and 5*a*, as with the pipe shown in Fig. 1, are sealed. The two part-casing pieces 2*a* and 3*a* may be rigidly connected to one another at the longitudinal joints; these longitudinal joints may however, also be formed as articulated joints, with, if necessary, a predetermined rigidity.

Fig. 5 shows a further pipe 1*d* comprising two half shells each provided with longitudinal flanges. The longitudinal flanges 18*a* and 19*a* of the part-casing piece 2*b* and the longitudinal flanges 20*a* and 21*a* of the part-casing piece 3*b* are, in this instance, directed outwards and are connected to one another by clamping members 6*b* and 7*b* for the introduction and anchoring of which recesses 8*b* are provided in the flanges. The pipes of the embodiment shown in Fig. 5 are suitable for laying in open trenches. For this a construction pit is suitably made, the base of which lies approximately at the same height as the trench base. The part-casing pieces 2*b* and 3*b* are conveyed with a crane or a similar lifting apparatus into the open construction pit and these are joined together to form pipes 1*d*. The finished pipes are then brought, either via a sliding path or using lifting apparatus, individually into their ultimate position and are joined together to form the pipeline, the successive pipes being connected to one another at transverse joints.

In Fig. 6 two pipe sections 1*e* and 1*f* are shown which are basically of the same construction as the pipe according to Fig. 1. However, in the case of the arrangement shown in Fig. 6, the two part-casing pieces 2*c* and 3*c* of each pipe are axially displaced in relation to one another, the forward end of the pipe 1*e* being formed stepped so that this pipe is connected to the next pipe 1*f* at two semi-circular lateral joints 22, 23 and, in addition, at two longitudinal joints 24 and 25 which lie flush with the longitudinal joints 4*b* and 5*b*, respectively, of the pipe. In consequence of the axially displaced lateral-joints 22 and 23, the resultant pipeline is rigid.

The part-casing pieces of the embodiments shown in Figs. 1 to 5 may be arranged in axially offset disposition in like manner to the embodiment shown in Fig. 6 to provide a rigid pipeline with displaced lateral-joints.

Besides circular pipes, pipes of other cross-section may be used in the method of the present invention such as for example, pipes of rectangular or square cross-section.

WHAT WE CLAIM IS:—

1. A method of constructing large cross-section underground pipes or tunnels by joining together reinforced concrete pipes in end-to-end disposition to form a pipeline, characterised in that the reinforced concrete pipes are assembled from prefabricated completed part-casing pieces which are connected together at their longitudinal joints at the building site before laying and the assembled pipes are then brought one after the other into their final underground positions.

2. A method according to claim 1 characterised in that the longitudinal joints are sealed before laying the pipes.

3. A method according to claim 1 or 2 characterised in that the part-casing pieces are connected together by clamping members.

4. A method according to any one of claims 1 to 3, characterised in that the longitudinal joints are formed as articulated joints.

5. A method according to any one of claims 1 to 4, characterised in that the part-casing pieces are formed as segments having the same centre angles.

6. A method according to any one of claims 1 to 5, characterised in that the pipeline is laid in manner known *per se* by the pressing through method.

7. A method according to any one of claims 1 to 6, characterised in that with several pipes the part-casing pieces of the successive pipe sections are arranged displaced in respect of one another in the axial direction of each pipe and that in the pipeline the adjacent pipes of this construction are connected to one another at their stepped ends at lateral joints and longitudinal joints.

8. A large cross-section underground

pipe or tunnel comprising a plurality of reinforced concrete pipes joined together in end-to-end disposition to form a pipeline, characterised in that the reinforced concrete pipes comprise prefabricated completed part-casing pieces which have been connected together at their longitudinal joints at the building site prior to the placing of the assembled pipes in their final underground positions.

9. A pipe or tunnel according to claim 8 wherein a reinforced concrete finished part forming said part-casing piece has, in the vicinity of the longitudinal edges thereof, recesses adapted to receive clamping members.

10. A pipe or tunnel as claimed in claim 9, characterised in that at least one of the two longitudinal edges of the finished part is formed as a flange.

11. A pipe or tunnel according to claim 10, characterised in that the or each said flange is so directed as to lie inwardly of the finished pipe.

12. A pipe or tunnel according to claim 10, characterised in that the or each said flange is so directed as to lie outwardly of the finished pipe.

13 The method of constructing large cross-section underground pipes or tunnels substantially as hereinbefore described with reference to and as illustrated in the various figures of the accompanying drawings.

14. A large cross-section underground pipe or tunnel according to claim 8 substantially as hereinbefore described with reference to and as illustrated in the various figures of the accompanying drawings.

15. A large cross-section underground pipe or tunnel constructed in accordance with the method as claimed in any one of claims 1 to 7 and claim 13.

Agents for the Applicants,
SYDNEY E. M'CAW & CO.,
Chartered Patent Agents,
Saxone House,
52—56 Market Street,
Manchester M1 1PP

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1597534 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

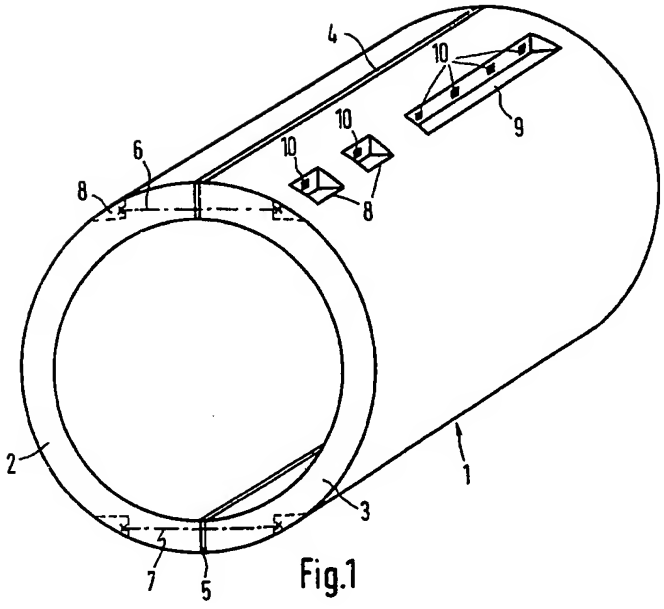


Fig.1

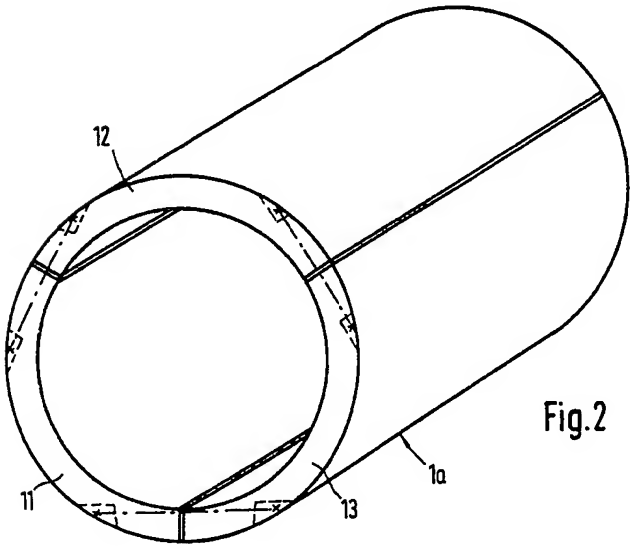


Fig.2

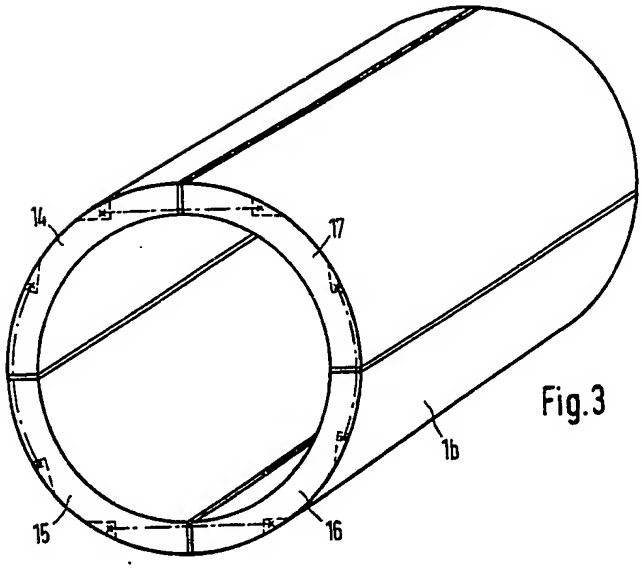


Fig.3

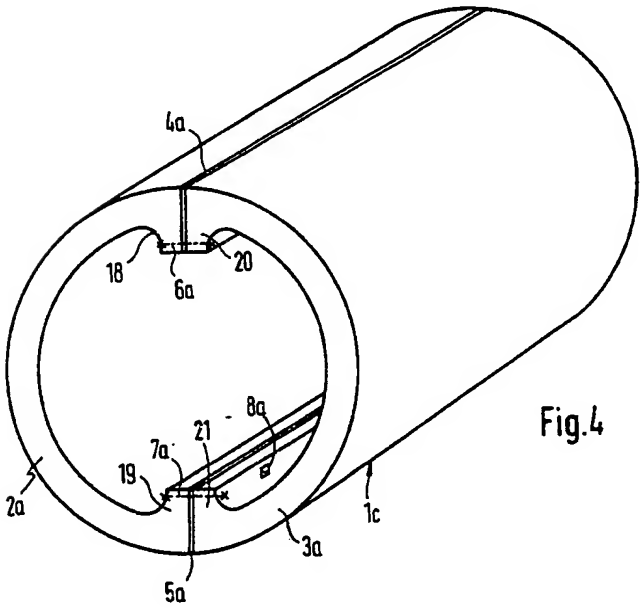
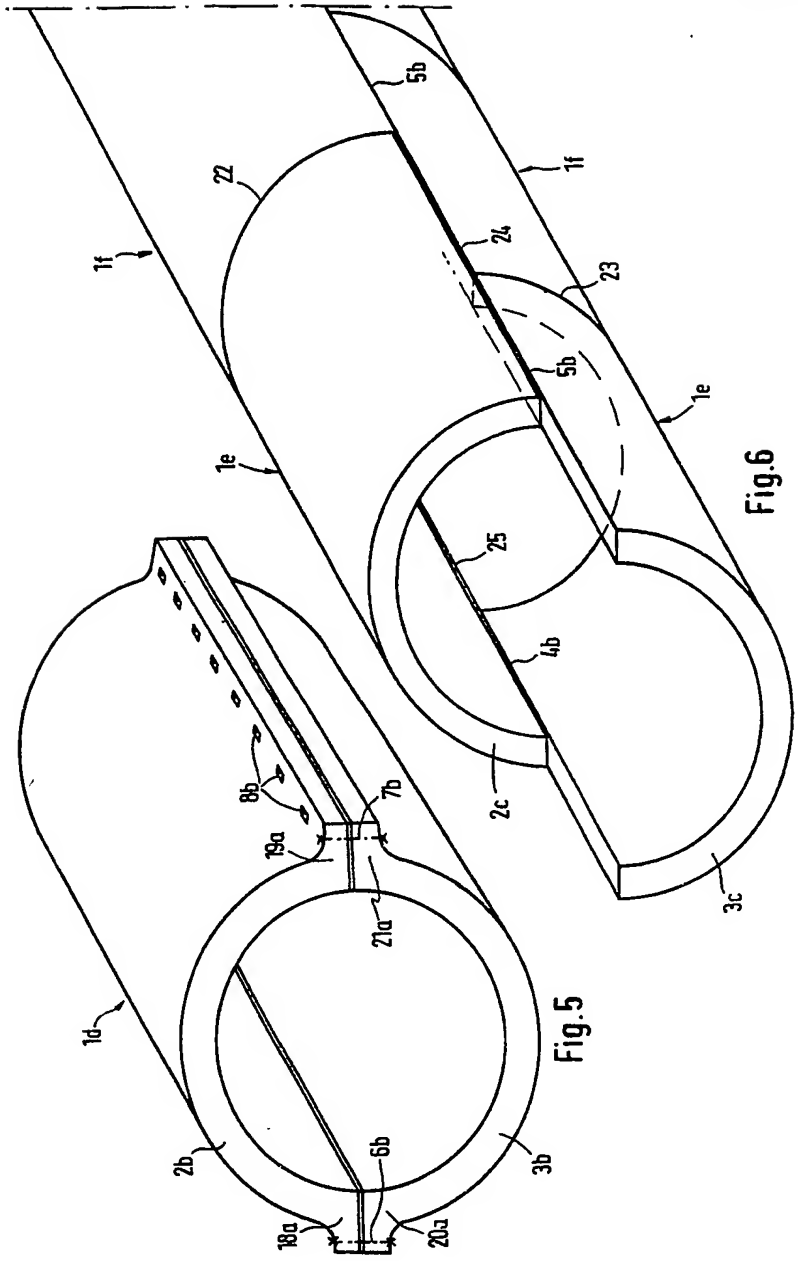


Fig.4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23
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3c
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21a
1d
2b
6b
3b
18a
20a

Fig.6

Fig.5